

APPLICATION UNDER UNITED STATES PATENT LAWS

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Invention: SUBSTRATE TREATMENT DEVICE, SUBSTRATE TREATMENT METHOD, AND
CLEANING METHOD FOR SUBSTRATE TREATMENT DEVICE

Inventor (s): Tadahiro ISHIZAKA
Kohei KAWAMURA
Hiroaki YOKOI
Takaya SHIMIZU
Takashi SHIGEOKA
Yasuhiro OSHIMA

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SPECIFICATION

SUBSTRATE TREATMENT DEVICE, SUBSTRATE TREATMENT METHOD, AND
CLEANING METHOD FOR SUBSTRATE TREATMENT DEVICE

CROSS-REFERENCE TO THE INVENTION

5 [0001] This application is based upon and claims the benefit of
priority from the prior Japanese Patent Application No. 2002-252273,
filed on August 30, 2002; the entire contents of which are
incorporated herein by reference.

10 BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0002] The present invention relates to a substrate treatment
device that treats a substrate, a substrate treatment method, and
a cleaning method for the substrate treatment device.

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2. DESCRIPTION OF THE RELATED ART

[0003] In recent years, there have been demands for higher speed
and increasing density in manufacturing semiconductor devices.
Accordingly, the hole diameter is becoming remarkably smaller,
20 resulting in a higher aspect ratio.

[0004] However, the increase in the aspect ratio tends to lower
step coverage of a thin film such as a TiN film and a TiSiN film
formed in holes. Such being the case, with the aim of forming thin
films excellent in step coverage, a deposition device that forms
25 films while supplying treatment gases alternately has been
presently drawing attention.

[0005] In forming the TiN film through the use of TiCl_4 and NH_3 ,
by such a deposition device, however, even when a trap is installed,

a large amount of yellow powder adheres to an inner wall of an exhaust pipe that is on a downstream side of the trap, concretely, the inner wall of the exhaust pipe whose inner pressure is maintained at an atmospheric pressure. Incidentally, this trap is intended for capturing NH_4Cl that is a byproduct of the reaction. When a TiSiN film is formed through the use of TiCl_4 , NH_3 , and SiH_2Cl_2 , white powder in addition to the yellow powder adheres to the inner wall of the exhaust pipe. These powders deposit at every repetition of the film formation, which will be a cause of clogging the pipe. Therefore, there is such a problem that frequent maintenance is necessary for removing the powders adhering to the inner wall of the exhaust pipe by opening the exhaust pipe. Incidentally, this problem may possibly occur also in a deposition device that forms films while supplying treatment gases simultaneously.

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BRIEF SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a substrate treatment device, a substrate treatment method, and a cleaning method for the substrate treatment device that are capable of reducing the clogging of an exhaust system.

[0007] A substrate treatment device according to an aspect of the present invention is characterized in that it includes: a treatment chamber in which a substrate is to be placed; a supply system configured to supply at least two kinds of treatment gases to the treatment chamber; an exhaust system having a pump, configured to exhaust the treatment gases from the treatment chamber; and a capturing unit interposed between the treatment chamber and the pump and containing fine grains, configured to capture by the fine grains

at least one kind of the treatment gas exhausted from the treatment chamber. According to this substrate treatment device of the present invention, a large amount of the treatment gas can be captured in the capturing unit. As a result, the clogging of the exhaust system can be reduced.

[0008] The fine grains contained in the capturing unit are preferably zeolite. Zeolite may be either synthetic zeolite or natural zeolite. The use of zeolite makes it possible to inhibit the reaction of the treatment gas captured by zeolite with the other treatment gas.

[0009] The capturing unit preferably captures the treatment gas that is liquid or solid at room temperature and at atmospheric pressure. Capturing such a treatment gas makes it possible to inhibit liquid or solid generated in the exhaust system.

[0010] The treatment gas captured by the capturing unit is preferably at least one of TiF_4 , TiCl_4 , TiBr_4 , TiI_4 , $\text{Ti}[\text{N}(\text{C}_2\text{H}_5\text{CH}_3)_2]_4$ (TEMAT), $\text{Ti}[\text{N}(\text{CH}_3)_2]_4$ (TDMAT), $\text{Ti}[\text{N}(\text{C}_2\text{H}_5)_2]_4$ (TDEAT), TaF_5 , TaCl_5 , TaBr_5 , TaI_5 , $\text{Ta}(\text{NC}(\text{CH}_3)_3)(\text{N}(\text{C}_2\text{H}_5)_2)_3$ (TBTDET), $\text{Ta}(\text{OC}_2\text{H}_5)_5$, $\text{Al}(\text{CH}_3)_3$, $\text{Zr}(\text{O}-t(\text{C}_4\text{H}_9))_4$, ZrCl_4 , SiH_4 , Si_2H_6 , SiH_2Cl_2 , and SiCl_4 . Capturing these treatment gases makes it possible to inhibit the generation of the powder in the exhaust system.

[0011] Another substrate treatment device according to the present invention is characterized in that it includes: a treatment chamber in which a substrate is to be placed; a supply system configured to supply at least two kinds of treatment gases to the treatment chamber; an exhaust system having a pump, configured to exhaust the treatment gases from the treatment chamber; and a capturing unit interposed between the treatment chamber and the pump,

configured to capture by a chemical action at least one kind of the treatment gas exhausted from the treatment chamber. The "chemical action" is accompanied by chemical reaction. The "chemical action" includes chemisorption. According to this substrate treatment device of the present invention, a large amount of the treatment gas can be captured in the capturing unit. As a result, the clogging of the exhaust system can be reduced.

[0012] The capturing unit preferably has a metal oxide to capture the treatment gas. The use of the metal oxide enables reliable capturing of the treatment gas. The metal oxide is preferably Al_2O_3 . The use of Al_2O_3 makes it possible to capture a large amount of the treatment gas even at reduced pressure.

[0013] Still another substrate treatment device of the present invention is characterized in that it includes: a treatment chamber in which a substrate is to be placed; a supply system configured to supply at least two kinds of treatment gases to the treatment chamber; an exhaust system having at least one pump, configured to exhaust the treatment gases from the treatment chamber; and an inert gas supply system configured to supply an inert gas into the exhaust system that is on a downstream side of the pump on a final stage. The inert gas is a gas inactive to the treatment gases. According to this substrate treatment device of the present invention, the liquefaction of the treatment gases can be inhibited. As a result, the clogging of the exhaust system can be reduced.

[0014] The inert gas preferably includes at least one of Ar, He, and N_2 . The use of these gases enables reliable inhibition of the liquefaction of the treatment gas.

[0015] Yet another substrate treatment device of the present

invention is characterized in that it includes: a treatment chamber in which a substrate is to be placed; a supply system configured to supply at least two kinds of treatment gases into the treatment chamber; an exhaust system having at least one pump, configured to exhaust the treatment gases from the treatment chamber; a heater configured to heat the exhaust system that is on a downstream side of the pump on a final stage. According to this substrate treatment device of the present invention, the liquefaction of the treatment gases can be inhibited. As a result, the clogging of the exhaust system can be reduced.

[0016] The treatment gases may include at least one of TiF_4 , TiCl_4 , TiBr_4 , TiI_4 , $\text{Ti}[\text{N}(\text{C}_2\text{H}_5\text{CH}_3)_2]_4$, $\text{Ti}[\text{N}(\text{CH}_3)_2]_4$, $\text{Ti}[\text{N}(\text{C}_2\text{H}_5)_2]_4$, TaF_5 , TaCl_5 , TaBr_5 , TaI_5 , $\text{Ta}(\text{NC}(\text{CH}_3)_3)(\text{N}(\text{C}_2\text{H}_5)_2)_3$, $\text{Ta}(\text{OC}_2\text{H}_5)_5$, $\text{Al}(\text{CH}_3)_3$, $\text{Zr}(\text{O}-\text{t}(\text{C}_4\text{H}_9))_4$, ZrCl_4 , SiH_4 , Si_2H_6 , SiH_2Cl_2 , and SiCl_4 . These gases are gases that may possibly cause the clogging of the exhaust system, but according to this substrate treatment device of the present invention, the clogging of the exhaust system can be reduced, which allows the use of these gases.

[0017] The substrate treatment device preferably further includes a supply controller configured to control the supply system to supply the treatment gases alternately. When the supply controller is provided, a high-quality film can be formed.

[0018] A substrate treatment method according to another aspect of the present invention includes: a metal-containing gas supply step of supplying a metal-containing gas at a first flow rate into a treatment chamber while the treatment chamber has a substrate placed therein; a metal-containing gas exhaust step of exhausting the metal-containing gas from the treatment chamber via an exhaust

system; a nitriding agent gas supply step of supplying a nitriding agent gas into the treatment chamber at a second flow rate that is 10 times as large as the first flow rate or at a larger rate; and a nitriding agent exhaust step of exhausting the nitriding agent gas from the treatment chamber via the exhaust system. The metal-containing gas exhaust step may be conducted either after the metal-containing gas supply step or during the metal-containing gas supply step. The nitriding agent gas supply step may be conducted either after the metal-containing gas supply step or during the metal-containing gas supply step. The nitriding agent gas exhaust step may be conducted either after the nitriding agent gas supply step or during the nitriding agent gas supply step. According to this substrate treatment method of the present invention, the clogging of the exhaust system can be reduced.

[0019] The nitriding agent gas is preferably supplied at a flow rate of 300 sccm to 1000 sccm. The supply of the nitriding agent gas at such a flow rate makes it possible to reduce the clogging of the exhaust system reliably.

[0020] The metal-containing gas may include at least one of TiF_4 , TiCl_4 , TiBr_4 , TiI_4 , $\text{Ti}[\text{N}(\text{C}_2\text{H}_5\text{CH}_3)_2]_4$, $\text{Ti}[\text{N}(\text{CH}_3)_2]_4$, $\text{Ti}[\text{N}(\text{C}_2\text{H}_5)_2]_4$, TaF_5 , TaCl_5 , TaBr_5 , TaI_5 , and $\text{Ta}(\text{NC}(\text{CH}_3)_3)(\text{N}(\text{C}_2\text{H}_5)_2)_3$. These gases are gases that may possibly cause the clogging of the exhaust system, but according to this substrate treatment method of the present invention, the clogging of the exhaust system can be reduced, which allows the use of these gases.

[0021] The nitriding agent gas preferably includes NH_3 . When it includes NH_3 , the clogging of the exhaust system can be more reliably reduced.

[0022] A cleaning method for a substrate treatment device according to still another aspect of the present invention is characterized in that it includes: a substrate treatment device preparing step of preparing a substrate treatment device that treats
5 a substrate by supplying a metal-containing gas and a nitriding agent gas to the substrate; and a nitriding agent gas supply step of supplying a nitriding agent gas into an exhaust system of the substrate treatment device while the substrate treatment device does not have the substrate placed therein. According to this
10 cleaning method for the substrate treatment device of the present invention, the clogging of the exhaust system can be reduced.

[0023] The nitriding agent gas supplied in the nitriding agent gas supply step is preferably supplied at a flow rate larger than a flow rate of the nitriding agent gas supplied for the treatment.
15 The supply of the nitriding agent gas at such a flow rate makes it possible to reduce the clogging of the exhaust system reliably.

[0024] The nitriding agent gas supplied in the nitriding agent gas supply step is preferably supplied at a flow rate of 300 sccm to 1000 sccm. The supply of the nitriding agent gas at such a flow
20 rate makes it possible to more reliably reduce the clogging of the exhaust system.

[0025] The metal-containing gas may include at least one of TiF_4 , TiCl_4 , TiBr_4 , TiI_4 , $\text{Ti}[\text{N}(\text{C}_2\text{H}_5\text{CH}_3)_2]_4$, $\text{Ti}[\text{N}(\text{CH}_3)_2]_4$, $\text{Ti}[\text{N}(\text{C}_2\text{H}_5)_2]_4$, TaF_5 , TaCl_5 , TaBr_5 , TaI_5 , and $\text{Ta}(\text{NC}(\text{CH}_3)_3)(\text{N}(\text{C}_2\text{H}_5)_2)_3$. These gases are gases
25 that may possibly cause the clogging of the exhaust system, but according to this cleaning method for the substrate treatment device of the present invention, the clogging of the exhaust system can be reduced, which allows the use of these gases.

[0026] The nitriding agent gas preferably includes NH_3 . When it includes NH_3 , the clogging of the exhaust system can be more reliably reduced.

[0027] Another cleaning method of a substrate treatment device
5 of the present invention is characterized in that it includes a nitriding agent gas supply step of supplying a nitriding agent gas into an exhaust system of the substrate treatment device that treats a substrate by supplying a metal-containing gas and a nitriding agent gas, while the substrate treatment device does not have the substrate
10 placed therein. According to this cleaning method of the present invention, the clogging of the exhaust system can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] FIG. 1 is a schematic block diagram showing a deposition
15 device according to a first embodiment.

[0029] FIG. 2 is a schematic vertical sectional view of a capturing unit according to the first embodiment.

[0030] FIG. 3 is a flowchart showing the flow of the treatment conducted in the deposition device according to the first
20 embodiment.

[0031] FIG. 4A to FIG. 4D are views schematically showing the treatment conducted in the deposition device according to the first embodiment.

[0032] FIG. 5 is a schematic block diagram of a deposition device
25 according to a second embodiment.

[0033] FIG. 6 is a schematic vertical sectional view of a capturing unit according to the second embodiment.

[0034] FIG. 7 is a flow chart showing the flow of the treatment

conducted in the deposition device according to the second embodiment.

[0035] FIG. 8A and FIG. 8B are views schematically showing the treatment conducted in the deposition device according to the second
5 embodiment.

[0036] FIG. 9 is a schematic block diagram of a deposition device according to a third embodiment.

[0037] FIG. 10 is a flowchart showing the flow of the treatment conducted in the deposition device according to the third
10 embodiment.

[0038] FIG. 11 is a view schematically showing the treatment conducted in the deposition device according to the third embodiment.

[0039] FIG. 12 is a schematic block diagram of a deposition device
15 according to a fourth embodiment.

[0040] FIG. 13 is a flowchart showing the flow of the treatment conducted in the deposition device according to the fourth embodiment.

[0041] FIG. 14 is a view schematically showing the treatment
20 conducted in the deposition device according to the fourth embodiment.

[0042] FIG. 15 is a flowchart showing the flow of the treatment conducted in a deposition device according to a fifth embodiment.

[0043] FIG. 16 is a flowchart showing the flow of the overall
25 treatment conducted in a deposition device according to a sixth embodiment.

[0044] FIG. 17 is a flowchart showing the flow of the treatment for one piece of wafer conducted in the deposition device according

to the sixth embodiment.

[0045] FIG. 18 is a view schematically showing the treatment conducted in the deposition device according to the sixth embodiment.

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DETAILED DESCRIPTION OF THE INVENTION

(First Embodiment)

[0046] Hereinafter, a deposition device according to a first embodiment of the present invention will be explained. FIG. 1 is a schematic block diagram of the deposition device according to this
10 embodiment.

[0047] As shown in FIG. 1, a deposition device 1 has a chamber 2 formed of, for example, aluminum or stainless steel. Incidentally, surface treatment, for example, the treatment of anodized aluminum may be applied to the surface of the chamber 2. The chamber 2 has
15 an opening 2A formed in a side portion thereof, and near the opening 2A, a gate valve 3 intended for allowing a semiconductor wafer (hereinafter, simply referred to as a 'wafer') W to be carried into or carried out of the chamber 2 is attached.

20 [0048] A susceptor 4 in a substantially disc shape to place the wafer W thereon is disposed in the chamber 2. The susceptor 4 is formed of, for example, ceramics such as AlN or Al_2O_3 . A heater 5 for heating the susceptor 4 to a predetermined temperature is provided in the susceptor 4. When the heater 5 heats the susceptor
25 4 to the predetermined temperature, the wafer W placed on the susceptor 4 is heated to the predetermined temperature.

[0049] Holes 4A intended for a wafer up/down are formed in a vertical direction at three places of the susceptor 4. Wafer

up/down pins 6 insertable into the holes 4A are provided at lower portions of the holes 4A respectively. The wafer up/down pins 6 are fixed onto a wafer up/down pin support table 7 so as to vertically stand. An air cylinder 8 is fixed to the wafer up/down pin support table 7. When a rod 8A of the air cylinder 8 is contracted by the drive of the air cylinder 8, the wafer up/down pins 6 are moved down so that the wafer W is placed on the susceptor 4. When the rod 8A is extended by the drive of the air cylinder 8, the wafer up/down pins 6 are moved up so that the wafer W is detached from the susceptor 4. A contractible/extendable bellows 9 covering the rod 8A is disposed in the chamber 2. By covering the rod 8A with the bellows 9, airtightness inside the chamber 2 is maintained.

[0050] An opening is formed in an upper portion of the chamber 2. A showerhead 10 to introduce TiCl_4 and NH_3 to the susceptor 4 is inserted in the opening. The showerhead 10 is divided into a TiCl_4 introducing portion 10A and an NH_3 introducing portion 10B. A large number of TiCl_4 introducing ports through which TiCl_4 is supplied are formed in the TiCl_4 introducing portion 10A. Similarly, a large number of NH_3 introducing ports through which NH_3 is supplied are formed in the NH_3 introducing portion 10B.

[0051] A TiCl_4 supply system 20 to supply TiCl_4 to the TiCl_4 introducing portion 10A is connected to the TiCl_4 introducing portion 10A of the showerhead 10. An NH_3 supply system 30 to supply NH_3 to the NH_3 introducing portion 10B is connected to the NH_3 introducing portion 10B.

[0052] The TiCl_4 supply system 20 has a TiCl_4 supply source 21 storing TiCl_4 therein. A TiCl_4 supply pipe 22 having one end connected to the TiCl_4 introducing portion 10A is connected to the

TiCl₄ supply source 21. A valve 23 and a mass flow controller (MFC) 24 to control the flow rate of TiCl₄ are disposed in the TiCl₄ supply pipe 22. When the valve 23 is opened while the mass flow controller 24 is in a controlled state, TiCl₄ is supplied to the TiCl₄ introducing portion 10A from the TiCl₄ supply source 21 at a predetermined flow rate.

[0053] The NH₃ supply system 30 has an NH₃ supply source 31 storing NH₃ therein. An NH₃ supply pipe 32 having one end connected to the NH₃ introducing portion 10B is connected to the NH₃ supply source 31. A valve 33 and a mass flow controller 34 to control the flow rate of NH₃ are disposed in the NH₃ supply pipe 32. When the valve 33 is opened while the mass flow controller 34 is in a controlled state, NH₃ is supplied to the showerhead 10 from the NH₃ supply source 31 at a predetermined flow rate.

[0054] A valve controller 35 that controls the valves 23, 33 so as to alternately open the valve 23, 33 is electrically connected to the valves 23, 33. Owing to such control over the valves 23, 33 by the valve controller 35, a TiN film excellent in step coverage is formed on the wafer W.

[0055] An exhaust system 40 to exhaust gases such as TiCl₄ and NH₃ is connected to a bottom portion of the chamber 2. The exhaust system 40 has an auto-pressure controller (APC) 41 to control the pressure inside the chamber 2. When conductance is adjusted by the auto-pressure controller 41, the pressure inside the chamber 2 is controlled at a predetermined pressure.

[0056] An exhaust pipe 42 is connected to the auto-pressure controller 41. The other end of the exhaust pipe 42 is open to the atmosphere. In the exhaust pipe 42, a main valve 43, a turbo

molecular pump 44, a trap 45, a capturing unit 46, a valve 47, a dry pump 48, and a capturing unit 49 are arranged in this order from an upstream side to a downstream side.

[0057] The turbo molecular pump 44 conducts high evacuation. The high evacuation by the turbo molecular pump 44 causes the pressure inside the chamber 2 to be maintained at a predetermined pressure. The turbo molecular pump 44 is also intended for exhausting excessive TiCl_4 , NH_3 , TiN , NH_4Cl , and so on from the chamber 2.

[0058] The trap 45 is intended for capturing NH_4Cl contained in an exhaust gas to remove NH_4Cl from the exhaust gas. The trap 45 has a housing 45A in which a flow-in port for letting the exhaust gas in therethrough and a flow-out port for letting the exhaust gas out therethrough are formed. A plate member 45B is disposed in the housing 45A, and the plate member 45B is cooled by a not-shown cooler. When powder of NH_4Cl comes into contact with the cooled plate member 45B, the plate member 45B adsorbs the powder of NH_4Cl by physical adsorption, so that NH_4Cl is removed from the exhaust gas.

[0059] The dry pump 48 is intended for assisting the turbo molecular pump 44. The dry pump 48 also conducts low evacuation of the inside of the chamber 2. When the pressure of a subsequent stage of the turbo molecular pump 44 is reduced by the dry pump 48, the exhaust rate of the turbo molecular pump 44 can be increased.

[0060] A roughing out pipe 50 for use in low evacuation by the dry pump 48 is connected to the exhaust pipe 42 between the valve 47 and the dry pump 48. The other end of the roughing out pipe 50 is connected to the exhaust pipe 42 between the auto-pressure controller 41 and the main valve 43. A valve 51 is disposed in the roughing out pipe 50.

[0061] The capturing units 46, 49 are intended for capturing TiCl_4 contained in the exhaust gas to remove TiCl_4 from the exhaust gas. The capturing unit 46 will be explained in detail below. FIG. 2 is a schematic vertical sectional view of the capturing unit 46 according to this embodiment.

[0062] As shown in FIG. 2, the capturing unit 46 has a housing 46C in which a flow-in port 46A for letting the exhaust gas in therethrough and a flow-out port 46B for letting the exhaust gas out therethrough are formed. Fine-grained synthetic zeolite 46D is contained in the housing 46C. When TiCl_4 contained in the exhaust gas comes into contact with the synthetic zeolite 46D, the synthetic zeolite 46D adsorbs TiCl_4 by physical adsorption, so that TiCl_4 is removed from the exhaust gas.

[0063] Hereinafter, the flow of the treatment conducted in the deposition device 1 will be explained, following FIG. 3 to FIG. 4D. FIG. 3 is a flowchart showing the flow of the treatment conducted in the deposition device 1 according to this embodiment, and FIG. 4A to FIG. 4D are views schematically showing the treatment conducted in the deposition device 1 according to this embodiment.

[0064] First, the main valve 43 and the valve 47 are closed, and while the valve 51 is in an open state, the dry pump 48 operates to conduct low evacuation of the inside of the chamber 2. Thereafter, when the pressure in the chamber 2 is reduced to some extent, the valve 51 is closed and at the same time, the main valve 43 and the valve 47 are opened, so that the low evacuation by the dry pump 48 is changed to the high evacuation by the turbo molecular pump 44 (Step 1A). Note that the dry pump 48 is kept operating even after this change.

[0065] After the pressure inside the chamber 2 is reduced to, for example, 1.33×10^{-2} Pa or lower, the gate valve 3 is opened and a not-shown transfer arm holding the wafer W extends to carry the wafer W into the chamber 2 (Step 2A).

5 [0066] Thereafter, the transfer arm contracts and the wafer W is placed on the wafer up/down pins 6. After the wafer W is placed on the wafer up/down pins 6, the wafer up/down pins 6 are moved down by the drive of the air cylinder 8, so that the wafer W is placed on the susceptor 4 having been heated to about 300°C to about 450°C
10 (Step 3A).

[0067] After the temperature of the wafer W is raised, the valve 23 is opened while the pressure inside the chamber 2 is kept at about 50 Pa to about 400 Pa, so that TiCl_4 is introduced to the wafer W from the TiCl_4 introducing portion 10A at a flow rate of about 30
15 sccm, as shown in FIG. 4A (Step 4A). When the introduced TiCl_4 comes into contact with the wafer W, TiCl_4 is adsorbed over the surface of the wafer W.

[0068] After a predetermined period of time passes, the valve 23 is closed to stop the supply of TiCl_4 , and at the same time, TiCl_4
20 remaining in the chamber 2 is exhausted from the chamber 2, as shown in FIG. 4B (Step 5A). Note that the pressure inside the chamber 2 at the time of the exhausting becomes 6.67×10^{-2} Pa or lower.

[0069] After a predetermined period of time passes, the valve 33 is opened, so that NH_3 is introduced to the wafer W from the NH_3 j
25 introducing portion 10B at a flow rate of about 100 sccm, as shown in FIG. 4C (Step 6A). When the introduced NH_3 comes into contact with TiCl_4 adsorbed by the wafer W, TiCl_4 and NH_3 react with each other, so that a TiN film is formed on the wafer W.

[0070] After a predetermined period of time passes, the valve 33 is closed to stop the supply of NH_3 , and at the same time, NH_3 and so on remaining in the chamber 2 are exhausted from the chamber 2, as shown in FIG. 4D (Step 7A). Note that the pressure inside the
5 chamber 2 at the time of the exhausting becomes 6.67×10^{-2} Pa or lower.

[0071] After a predetermined period of time passes, it is judged by a not-shown central controller whether or not 200 cycles of the treatment have been conducted, with the processes from Step 4A to
10 Step 7A being one cycle (Step 8A). When it is judged that 200 cycles of the treatment have not been conducted, the processes from Step 4A to Step 7A are conducted again.

[0072] When it is judged that 200 cycles of the treatment have been conducted, the wafer up/down pins 6 are moved up by the drive
15 of the air cylinder 8, so that the wafer W is detached from the susceptor 4 (Step 9A). Note that when 200 cycles of the treatment are conducted, the TiN film with a thickness of about 10 nm is formed on the wafer W.

[0073] Thereafter, after the gate valve 3 is opened, the not-
20 shown transfer arm extends to hold the wafer W. Finally, the transfer arm contracts to carry the wafer W out of the chamber 2 (Step 10A).

[0074] In this embodiment, since the capturing unit 46 containing the fine grains is disposed between the chamber 2 and the dry pump
25 48, the clogging of the exhaust pipe 42 can be reduced. To be more specific, yellow powder adhering to an inner wall of the exhaust pipe is generated by the reaction between TiCl_4 and NH_3 that are exhausted from the chamber. Concretely, the yellow powder is $\text{TiCl}_4 \cdot$

n NH_3 (n = 2, 4), which is generated by the reaction between TiCl_4 and NH_3 at about 150°C or lower. The possible reason why a large amount of the yellow powder adheres to the inner wall of the exhaust pipe maintained at the atmospheric pressure is that TiCl_4 is

5 liquefied or a large amount of TiCl_4 adheres to the inner wall of the exhaust pipe. Concretely, as for the liquefaction of TiCl_4 , when TiCl_4 is liquefied, it is difficult for the liquefied TiCl_4 to move. When NH_3 flows therein, the reaction between TiCl_4 and NH_3 occurs one after another. This is the possible reason for the adhesion

10 of a large amount of the yellow powder to the inner wall of the exhaust pipe maintained at the atmospheric pressure. As for the adhesion of a large amount of TiCl_4 to the inner wall of the exhaust pipe, at the atmospheric pressure, TiCl_4 is more easily adsorbed by the inner wall of the exhaust pipe and the adsorbed TiCl_4 is more

15 difficult to be detached than at the reduced pressure. Therefore, an adhesion amount of TiCl_4 to the inner wall of the exhaust pipe increases. When NH_3 flows therein, the reaction between TiCl_4 and NH_3 occurs one after another. This is the possible reason for the adhesion of a large amount of the yellow powder to the inner wall

20 of the exhaust pipe 42 maintained at the atmospheric pressure. Therefore, when TiCl_4 is captured at the reduced pressure, the generation of the yellow powder is inhibited, so that the adhesion of the yellow powder to the inner wall of the exhaust pipe maintained at the atmospheric pressure is inhibited. Here, a trap provided

25 in a conventional deposition device is installed under the condition of the reduced pressure, and therefore, this trap is also likely to be capable of capturing TiCl_4 , but the surface area of the trap is small. Accordingly, an amount of TiCl_4 captured by the trap is

very small, which is the possible reason for not allowing effective inhibition of the generation of the yellow powder. In this embodiment, on the other hand, since TiCl_4 is captured by the fine grains, the surface area is large, so that a large amount of TiCl_4 can be captured. Consequently, it is possible to greatly reduce the yellow powder adhering to the inner wall of the exhaust pipe 42, resulting in the reduction in the clogging of the exhaust pipe 42. As a result, maintenance frequency can be lowered.

[0075] In this embodiment, owing to the use of the synthetic zeolite 46D, TiCl_4 adsorbed by the synthetic zeolite 46D does not easily react with NH_3 that flows in thereafter. As a result, reliable inhibition of the generation of the yellow powder is realized.

[0076] In this embodiment, TiCl_4 and NH_3 are alternately supplied, and even in such a case, the generation of the yellow powder can be reliably inhibited. Specifically, the comparison of the alternate supply of TiCl_4 and NH_3 with the simultaneous supply of TiCl_4 and NH_3 shows that an amount of TiCl_4 exhausted from the chamber 2 is larger in the alternate supply. Therefore, an amount of the generated yellow powder becomes larger in the alternate supply than in the simultaneous supply. In this embodiment, since TiCl_4 can be reliably captured, the generation of the yellow powder can be reliably inhibited even when TiCl_4 and NH_3 are alternately supplied. (Second Embodiment)

[0077] Hereinafter, a second embodiment of the present invention will be explained. Note that some of the contents of this embodiment and embodiments thereafter that are the same as those in the previous embodiment will be omitted in the explanation. In this embodiment,

the explanation will be given on an example where a capturing unit contains aluminum oxide (Al_2O_3) in addition to synthetic zeolite.

[0078] FIG. 5 is a schematic block diagram of a deposition device according to this embodiment. As shown in FIG. 5, a deposition
5 device 1 has an SiH_2Cl_2 supply system 60. The SiH_2Cl_2 supply system 60 has an SiH_2Cl_2 supply source 61 storing SiH_2Cl_2 therein. An SiH_2Cl_2 supply pipe 62 having one end connected to a TiCl_4 supply pipe 22 is connected to the SiH_2Cl_2 supply source 61. A valve 63 and a mass flow controller 64 to control the flow rate of SiH_2Cl_2 are disposed
10 in the SiH_2Cl_2 supply pipe 62. The valve 63 is opened while the valve 23 is in a closed state and the mass flow controller 64 is in a controlled state, so that SiH_2Cl_2 is supplied to a TiCl_4 introducing portion 10A from the SiH_2Cl_2 supply source 61 at a predetermined flow rate.

15 [0079] A valve controller 35 to control the valves 23, 33, 63 so as to open the valve 23, 33, 63 by turns is electrically connected to the valve 63. Owing to such control over the valves 23, 33, 63 by the valve controller 35, a TiSiN film excellent in step coverage is formed on a wafer W.

20 [0080] Next, a capturing unit 46 in this embodiment will be explained. FIG. 6 is a schematic vertical sectional view of the capturing unit 46 according to this embodiment. As shown in FIG. 6, fine-grained synthetic zeolite 46D and fine-grained aluminum oxide 46E are put in an alternate layered state in the capturing
25 unit 46. When SiH_2Cl_2 contained in an exhaust gas comes into contact with the aluminum oxide 46E, SiH_2Cl_2 is adsorbed by the aluminum oxide 46E by chemisorption, so that SiH_2Cl_2 is removed from the exhaust gas.

[0081] Hereinafter, the flow of the treatment conducted in the deposition device 1 will be explained, following FIG. 7 to FIG. 8B. FIG. 7 is a flowchart showing the flow of the treatment conducted in the deposition device 1 according to this embodiment, and FIG.

5 8A and FIG. 8B are views schematically showing the treatment conducted in the deposition device 1 according to this embodiment.

[0082] A dry pump 48 is operated to conduct low evacuation of the inside of a chamber 2. Thereafter, the low evacuation by the dry pump 48 is changed to high evacuation by a turbo molecular pump 44
10 (Step 1B).

[0083] After the pressure inside the chamber 2 is reduced to, for example, 1.33×10^{-2} Pa or lower, a not-shown transfer arm holding the wafer W extends to carry the wafer W into the chamber 2 (Step 2B). Thereafter, wafer up/down pins 6 are moved down to place the
15 wafer W on a susceptor 4 (Step 3B).

[0084] After the temperature of the wafer W is raised, the valve 23 is opened while the pressure inside the chamber 2 is kept at about 50 Pa to about 400 Pa, so that TiCl_4 is introduced from the TiCl_4 introducing portion 10A (Step 4B). After a predetermined period
20 of time passes, the valve 23 is closed to stop the supply of TiCl_4 and at the same time, TiCl_4 remaining in the chamber 2 is exhausted from the chamber 2 (Step 5B).

[0085] After a predetermined period of time passes, the valve 63 is opened, so that SiH_2Cl_2 is introduced from the TiCl_4 introducing portion 10A at a flow rate of about 30 sccm, as shown in FIG. 8A
25 (Step 6B). When the introduced SiH_2Cl_2 comes into contact with TiCl_4 adsorbed by the wafer W, TiCl_4 and SiH_2Cl_2 react with each other, so that a film in which Ti and Si are bonded together is formed on

the wafer W. After a predetermined period of time passes, the valve 61 is closed to stop the supply of SiH_2Cl_2 , and at the same time, SiH_2Cl_2 and so on remaining in the chamber 2 are exhausted from the chamber 2, as shown in FIG. 8B (Step 7B).

5 [0086] After a predetermined period of time passes, the valve 33 is opened, so that NH_3 is introduced from an NH_3 introducing portion 10B (Step 8B). When the introduced NH_3 comes into contact with the film in which Ti and Si are bonded together on the wafer W, the film in which Ti and Si are bonded together react with NH_3 , so that a
10 TiSiN film is formed on the wafer W. After a predetermined period of time passes, the valve 33 is closed to stop the supply of NH_3 , and at the same time, NH_3 and so on remaining in the chamber 2 are exhausted from the chamber 2 (Step 9B).

[0087] After a predetermined period of time passes, it is judged
15 whether or not 200 cycles of the treatment, with the processes from Step 4B to Step 9B being one cycle, have been conducted (Step 10B). When it is judged that 200 cycles of the treatment have not been conducted, the processes from Step 4B to Step 9B are conducted again.

[0088] When it is judged that 200 cycles of the treatment have
20 been conducted, the wafer up/down pins 6 are moved up, so that the wafer W is detached from the susceptor 4 (Step 11B). Finally, the wafer W is carried out of the chamber 2 by the not-shown transfer arm (Step 12B).

[0089] In this embodiment, since the capturing unit 46 containing
25 the aluminum oxide 46E is disposed between the chamber 2 and the dry pump 48, the clogging of an exhaust pipe 42 can be reduced. To be more specific, white powder adhering to an inner wall of the exhaust pipe is generated by the reaction between SiH_2Cl_2 and NH_3 ,

that are exhausted from the chamber. Specifically, the white powder is NH_4Cl . The possible reason why a large amount of the white powder adheres to the inner wall of the exhaust pipe maintained at the atmospheric pressure is that a large amount of SiH_2Cl_2 adheres to the inner wall of the exhaust pipe. Concretely, as described above, at the atmospheric pressure, SiH_2Cl_2 is more easily adsorbed by the inner wall of the exhaust pipe and the adsorbed SiH_2Cl_2 is more difficult to be detached than at the reduced pressure. Therefore, an adhesion amount of SiH_2Cl_2 to the inner wall of the exhaust pipe increases. When NH_3 flows therein, the reaction between SiH_2Cl_2 and NH_3 occurs one after another. This is the possible reason for the adhesion of a large amount of the white powder to an inner wall of the exhaust pipe maintained at the atmospheric pressure. Here, NH_4Cl is also captured in a trap provided in a conventional deposition device, but NH_4Cl that this trap is capable of capturing is mainly NH_4Cl generated in the chamber, and NH_4Cl generated at the atmospheric pressure cannot be captured. This is the possible reason for not allowing effective inhibition of the generation of the white powder. In this embodiment, on the other hand, SiH_2Cl_2 that is a generating source of NH_4Cl is captured in advance at the reduced pressure, so that it is possible to greatly reduce the white powder adhering to the inner wall of the exhaust pipe 42, thereby reducing the clogging of the exhaust pipe 42. As a result, maintenance frequency can be lowered.

[0090] In this embodiment, the aluminum oxide 46E captures SiH_2Cl_2 by chemisorption. Here, since chemisorption is the adsorption by chemical reaction, even a gas can be adsorbed reliably. Accordingly, an amount of SiH_2Cl_2 captured in this case is larger than that when

SiH_2Cl_2 is captured by physical adsorption.

[0091] In this embodiment, since the aluminum oxide 46E is contained in a fine-grained state, so that the surface area thereof is large. Therefore, a larger amount of SiH_2Cl_2 can be captured.

5 [0092] In this embodiment, TiCl_4 , SiH_2Cl_2 , and NH_3 are supplied by turns, and even in such a case, the generation of the white powder can be reliably inhibited. Specifically, the comparison of the supply of TiCl_4 , SiH_2Cl_2 , and NH_3 by turns with the simultaneous supply of TiCl_4 , SiH_2Cl_2 , and NH_3 shows that an amount of SiH_2Cl_2 exhausted
10 from the chamber 2 is larger in the supply by turns. Therefore, an amount of the generated white powder is larger in the supply by turns than in the simultaneous supply. In this embodiment, since SiH_2Cl_2 can be reliably captured, the generation of the white powder can be reliably inhibited even when TiCl_4 , SiH_2Cl_2 , and NH_3 are
15 supplied by turns. Since the capturing unit 46E also contains the synthetic zeolite 46D, the same effect as in the first embodiment is obtainable.

(Third Embodiment)

[0093] Hereinafter, a third embodiment of the present invention
20 will be explained. In this embodiment, the explanation will be given on an example where provided is an N_2 supply system to supply N_2 into an exhaust pipe that is on a downstream side of a dry pump.

[0094] FIG. 9 is a schematic block diagram of a deposition device according to this embodiment. As shown in FIG. 9, an N_2 supply system
25 70 to supply N_2 into an exhaust pipe 42 is connected to the exhaust pipe 42 that is on a downstream side of a dry pump 48. The N_2 supply system 70 has an N_2 supply source 71 storing N_2 therein. An N_2 supply pipe 72 having one end connected to the exhaust pipe 42 that is on

the downstream side of the dry pump 48 is connected to the N₂ supply source 71. A valve 73 and a mass flow controller 74 to control the flow rate of N₂ are disposed in the N₂ supply pipe 72. When the valve 73 is opened while the mass flow controller 74 is in a controlled state, N₂ is supplied into the exhaust pipe 42 from the N₂ supply source 71 at a predetermined flow rate.

[0095] Hereinafter, the flow of the treatment conducted in a deposition device 1 will be explained, following FIG. 10 and FIG. 11. FIG. 10 is a flowchart showing the flow of the treatment conducted in the deposition device 1 according to this embodiment, and FIG. 11 is a view schematically showing the treatment conducted in the deposition device 1 according to this embodiment.

[0096] The dry pump 48 is operated to conduct low evacuation of the inside of a chamber 2. Thereafter, the low evacuation by the dry pump 48 is changed to high evacuation by a turbo molecular pump 44 (Step 1C).

[0097] After the pressure inside the chamber 2 is reduced to, for example, 1.33×10^{-2} Pa or lower, a not-shown transfer arm holding a wafer W extends to carry the wafer W into the chamber 2 (Step 2C). Thereafter, wafer up/down pins 6 are moved down to place the wafer W on a susceptor 4 (Step 3C).

[0098] After the temperature of the wafer W is raised, a valve 23 is opened while the pressure inside the chamber 2 is kept at about 50 Pa to about 400 Pa, so that TiCl₄ is introduced from a TiCl₄ introducing portion 10A. At this time, N₂ is also supplied into the exhaust pipe 42 at a flow rate of about 1 L/min to about 50 L/min as shown in FIG. 11 (Step 4C). After a predetermined period of time passes, the valve 23 is closed to stop the supply of TiCl₄ and at

the same time, TiCl_4 remaining in the chamber 2 is exhausted from the chamber 2 (Step 5C).

[0099] After a predetermined period of time passes, the valve 33 is opened, so that NH_3 is introduced from an NH_3 introducing portion 10B (Step 6C). After a predetermined period of time passes, the valve 33 is closed to stop the supply of NH_3 and at the same time, NH_3 and so on remaining in the chamber 2 are exhausted from the chamber 2 (Step 7C).

[0100] After a predetermined period of time passes, it is judged whether or not 200 cycles of the treatment have been conducted (Step 8C). When it is judged that 200 cycles of the treatment have not been conducted, the processes from Step 4C to Step 7C are conducted again.

[0101] When it is judged that 200 cycles of the treatment have been conducted, the valve 73 is closed to stop the supply of N_2 to the exhaust pipe 42 (Step 9C). Thereafter, the wafer up/down pins 6 are moved up, so that the wafer W is detached from the susceptor 4 (Step 10C). Finally, the wafer W is carried out of the chamber 2 by the not-shown transfer arm (Step 11C).

[0102] In this embodiment, since the N_2 supply system 70 to supply N_2 is disposed in the exhaust pipe 42 that is on the downstream side of the dry pump 48, the clogging of the exhaust pipe 42 can be reduced. To be more specific, the inside of the exhaust pipe 42 that is on the downstream side of the dry pump 48 is kept at the atmospheric pressure. Therefore, when N_2 is supplied into the exhaust pipe 42 that is on the downstream side of the dry pump 48, the pressure of TiCl_4 is lowered to reduce liquid TiCl_4 . Further, the supply of N_2 causes TiCl_4 to be pushed out, so that TiCl_4 is not easily adsorbed

by an inner wall of the exhaust pipe 42 and TiCl_4 adsorbed by the inner wall of the exhaust pipe 42 is easily detached. Consequently, yellow powder adhering to the inner wall of the exhaust pipe 42 can be greatly reduced to reduce the clogging of the exhaust pipe 42.

5 As a result, maintenance frequency can be lowered.

(Fourth Embodiment)

[0103] Hereinafter, a fourth embodiment of the present invention will be explained. In this embodiment, the explanation will be given on an example where provided is a tape heater for heating an exhaust pipe that is on a downstream side of a dry pump.

[0104] FIG. 12 is a schematic block diagram of a deposition device according to this embodiment. As shown in FIG. 12, a tape heater 80 for heating an exhaust pipe 42 is wound around an external wall of the exhaust pipe 42 that is on a downstream side of a dry pump 48. A tape heater controller 81 that controls the heating temperature of the tape heater 80 by adjusting an electric current passing through the tape heater 80 is electrically connected to the tape heater 80.

[0105] Hereinafter, the flow of the treatment conducted in a deposition device 1 will be explained, following FIG. 13 and FIG. 14. FIG. 13 is a flowchart showing the flow of the treatment conducted in the deposition device 1 according to this embodiment, and FIG. 14 is a view schematically showing the treatment conducted in the deposition device 1 according to this embodiment.

[0106] The dry pump 48 is operated to conduct low evacuation of the inside of a chamber 2. Thereafter, the low evacuation by the dry pump 48 is changed to high evacuation by a turbo molecular pump 44 (Step 1D).

[0107] After the pressure inside the chamber 2 is reduced to, for example, 1.33×10^{-2} Pa or lower, a not-shown transfer arm holding a wafer W extends to carry the wafer W into the chamber 2 (Step 2D). Thereafter, wafer up/down pins 6 are moved down to place the wafer W on a susceptor 4. Further, the exhaust pipe 42 is heated by the tape heater 80 to about 60°C to about 100°C (Step 3D).

[0108] After the temperature of the wafer W is raised and the temperature of the exhaust pipe 42 becomes stable at 60°C to 100°C, a valve 23 is opened while the pressure inside the chamber 2 is kept at about 50 Pa to about 400 Pa, so that TiCl_4 is introduced from a TiCl_4 introducing portion 10A as shown in FIG. 14 (Step 4D). After a predetermined period of time passes, the valve 23 is closed to stop the supply of TiCl_4 and at the same time, TiCl_4 remaining in the chamber 2 is exhausted from the chamber 2 (Step 5D).

[0109] After a predetermined period of time passes, a valve 33 is opened, so that NH_3 is introduced from an NH_3 introducing portion 10B (Step 6D). After a predetermined period of time passes, the valve 33 is closed to stop the supply of NH_3 and at the same time, NH_3 and so on remaining in the chamber 2 are exhausted from the chamber 2 (Step 7D).

[0110] After a predetermined period of time passes, it is judged whether or not 200 cycles of the treatment have been conducted (Step 8D). When it is judged that 200 cycles of the treatment have not been conducted, the processes from Step 4D to Step 7D are conducted again.

[0111] When it is judged that 200 cycles of the treatment have been conducted, the heating of the exhaust pipe 42 by the tape heater 80 is stopped (Step 9D). Thereafter, the wafer up/down pins 6 are

moved up, so that the wafer W is detached from the susceptor 4 (Step 10D). Finally, the wafer W is carried out of the chamber 2 by the not-shown transfer arm (Step 11D).

[0112] In this embodiment, since the tape heater 80 for heating the exhaust pipe 42 that is on the downstream side of the dry pump 48 is provided, the clogging of the exhaust pipe 42 can be reduced. To be more specific, when the exhaust pipe 42 that is on the downstream side of the dry pump 48 is heated, TiCl_4 is not easily liquefied and liquid TiCl_4 is liable to turn into gas again. Accordingly, liquid TiCl_4 is reduced. Further, when the exhaust pipe 42 that is on the downstream side of the dry pump 48 is heated, TiCl_4 adsorbed by an inner wall of the exhaust pipe 42 is easily detached from the inner wall of the exhaust pipe 42. Consequently, an amount of TiCl_4 adhering to the inner wall of the exhaust pipe 42 is reduced. This makes it possible to greatly reduce yellow powder adhering to the inner wall of the exhaust pipe 42 to reduce the clogging of the exhaust pipe 42. As a result, maintenance frequency can be lowered.

(Fifth Embodiment)

[0113] Hereinafter, a fifth embodiment of the present invention will be explained. In this embodiment, the explanation will be given on an example where NH_3 is supplied at a flow rate about 10 times as large as the flow rate of TiCl_4 or at a larger flow rate.

[0114] FIG. 15 is a flow chart showing the flow of the treatment conducted in a deposition device 1 according to this embodiment. Note that the deposition device of this embodiment is a similar one to the deposition device in the first embodiment, but the capturing unit 46 is not disposed.

[0115] A dry pump 48 is operated to conduct low evacuation of the inside of a chamber 2. Thereafter, the low evacuation by the dry pump 48 is changed to high evacuation by a turbo molecular pump 44 (Step 1E).

5 [0116] After the pressure inside the chamber 2 is reduced to, for example, 1.33×10^{-2} Pa or lower, a not-shown transfer arm holding a wafer W extends to carry the wafer W into the chamber 2 (Step 2E). Thereafter, wafer up/down pins 6 are moved down to place the wafer W on a susceptor 4 (Step 3E).

10 [0117] After the temperature of the wafer W is raised, a valve 23 is opened while the pressure inside the chamber 2 is kept at about 50 Pa to about 400 Pa, so that TiCl_4 is introduced from a TiCl_4 introducing portion 10A at a flow rate of about 30 sccm (Step 4E). After a predetermined period of time passes, the valve 23 is closed
15 to stop the supply of TiCl_4 and at the same time, TiCl_4 remaining in the chamber 2 is exhausted from the chamber 2 (Step 5E).

[0118] After a predetermined period of time passes, a valve 33 is opened, so that NH_3 is introduced from an NH_3 introducing portion 10B at a flow rate of about 300 sccm to about 1000 sccm (Step 6E).

20 After a predetermined period of time passes, the valve 33 is closed to stop the supply of NH_3 and at the same time, NH_3 and so on remaining in the chamber 2 are exhausted from the chamber 2 (Step 7E).

[0119] After a predetermined period of time passes, it is judged whether or not 200 cycles of the treatment have been conducted (Step
25 8E). When it is judged that 200 cycles of the treatment have not been conducted, the processes from Step 4E to Step 7E are conducted again.

[0120] When it is judged that 200 cycles of the treatment have

been conducted, the wafer up/down pins 6 are moved up, so that the wafer W is detached from the susceptor 4 (Step 9E). Finally, the wafer W is carried out of the chamber 2 by the not-shown transfer arm (Step 10E).

5 [0121] In this embodiment, since NH_3 is supplied at a flow rate about 10 times as large as the flow rate of TiCl_4 or at a larger rate, the clogging of an exhaust pipe 42 can be reduced. As a result, maintenance frequency can be lowered.

(Example)

10 [0122] Hereinafter, an example will be explained. In this example, the deposition device according to the fifth embodiment was used and the degree of the clogging of the exhaust pipe was observed.

[0123] Measurement conditions will be explained. In this
15 example, a TiN film was formed on a wafer, using the deposition device according to the fifth embodiment. Incidentally, the TiN film with a thickness of about 10 nm was formed on each of the wafers. TiCl_4 was supplied at a flow rate of about 30 sccm and NH_3 was supplied at a flow rate of about 800 sccm. Further, for comparison with this
20 example, TiCl_4 was supplied at a flow rate of about 30 sccm and NH_3 was supplied at a flow rate of about 100 sccm, and the degree of the clogging of the exhaust pipe 42 in this case was also observed.

[0124] The measurement results will be discussed. When TiCl_4 was supplied at a flow rate of about 30 sccm and NH_3 was supplied at
25 a flow rate of about 100 sccm, the exhaust pipe was clogged at the time after the TiN film was formed on 30 pieces of the wafer and maintenance was required. On the other hand, when TiCl_4 was supplied at a flow rate of about 30 sccm and NH_3 was supplied at a flow rate

of about 800 sccm, even the TiN film formation on 100 pieces of the wafers did not cause the exhaust pipe to be clogged, and maintenance was not required. It has been confirmed from these results that the supply of NH_3 at a flow rate about 10 times as large as the flow
5 rate of TiCl_4 or at a larger rate reduces the clogging of the exhaust pipe to lower maintenance frequency.

(Sixth Embodiment)

[0125] Hereinafter, a sixth embodiment of the present invention will be explained. In this embodiment, the explanation will be
10 given on an example where NH_3 is periodically supplied into an exhaust pipe while a deposition device does not have a wafer carried therein.

[0126] FIG. 16 is a flowchart showing the flow of the overall treatment conducted in the deposition device according to this embodiment, FIG. 17 is a flowchart showing the flow of the treatment
15 for one piece of wafer conducted in the deposition device according to this embodiment, and FIG. 18 is a view schematically showing the treatment conducted in the deposition device according to this embodiment. The deposition device of this embodiment is a similar one to the deposition device of the first embodiment, but the
20 capturing unit 46 is not disposed.

[0127] First, a TiN film is formed on the first wafer W (Step 1F). Concretely, high evacuation is first conducted by a turbo molecular pump 44 (Step 101F). After the pressure inside a chamber 2 is reduced to, for example, 1.33×10^{-2} Pa or lower, the first wafer W is carried
25 into the chamber 2 and placed on a susceptor 4 thereafter (Step 102F, Step 103F). After the temperature of the wafer W is raised, TiCl_4 is introduced from a TiCl_4 introducing portion 10A at a flow rate of about 30 sccm (Step 104F). Thereafter, the supply of TiCl_4 is

stopped, and at the same time, TiCl_4 remaining in the chamber 2 is exhausted from the chamber 2 (Step 105F). After a predetermined period of time passes, NH_3 is introduced at a flow rate of about 100 sccm (Step 106F). Thereafter, the supply of NH_3 is stopped, and
5 at the same time, NH_3 and so on remaining in the chamber 2 are exhausted from the chamber 2 (Step 107F). After a predetermined period of time passes, it is judged whether or not 200 cycles of the treatment have been conducted (Step 108F). When it is judged that 200 cycles of the treatment have not been conducted, the
10 processes from Step 104F to Step 107F are conducted again. When it is judged that 200 cycles of the treatment have been conducted, the wafer W is detached from the susceptor 4, and the first wafer W is carried out of the chamber 2 by a not-shown transfer arm (Step 109F, Step 110F).

15 [0128] Subsequently, the same processes as in Step 101F to Step 110F are also conducted for the second, third, ..., twenty-fifth wafers W respectively (Step 2F to Step 25F).

[0129] After the twenty-fifth wafer W is carried out of the chamber 2, a valve 33 is opened while the turbo molecular pump 44
20 and a dry pump 48 are in operation, so that NH_3 is introduced from an NH_3 introducing portion 10B at a flow rate of about 300 sccm to about 1000 sccm, as shown in FIG. 18 (Step 26F). The introduced NH_3 is supplied into an exhaust pipe 42 that is on a downstream side of the dry pump 48 via the chamber 2. The supply of NH_3 while the
25 deposition device 1 does not have the wafer W carried therein is conducted periodically. Specifically, it is conducted for, for example, every 1 lot (25 pieces of the wafers). After a predetermined period of time passes, the valve 33 is closed to stop

the supply of NH_3 (Step 27F).

[0130] In this embodiment, since NH_3 is supplied into the exhaust pipe 42 while the deposition device 1 does not have the wafer W carried therein, the clogging of the exhaust pipe 42 can be reduced.

5 Therefore, the frequency for removing yellow powder by opening the exhaust pipe 42 can be lowered.

[0131] It should be noted that the present invention is not limited to the described contents in the above embodiments, and the structure, the materials, the arrangement of each member, and so on are appropriately changeable within a range not departing from the spirit of the present invention. Table 1 presents examples of treatment gases for forming film species and these films. TiCl_4 and NH_3 are used in the first embodiment and the third to sixth embodiments, and TiCl_4 , SiH_2Cl_2 , and NH_3 are used in the second embodiment, but the treatment gases shown in Table 1 are also usable.

[Table 1]

Film Species	First Treatment Gas	Second Treatment Gas	Third Treatment Gas	Film Species	First Treatment Gas	Second Treatment Gas	Third Treatment Gas
TiN	TiCl_4	NH_3	-	TaN	TaF_5	NH_3	-
	TiF_4	NH_3	-		TaCl_5	NH_3	-
	TiBr_4	NH_3	-		TaBr_5	NH_3	-
	TiI_4	NH_3	-		TaI_5	NH_3	-
	TEMAT	NH_3	-		TBTDET	NH_3	-
	TDMAT	NH_3	-	TaSiN	TaF_5	NH_3	SiH_4
	TDEAT	NH_3	-		TaCl_5	NH_3	SiH_4
TiSiN	TiCl_4	NH_3	SiH_4		TaBr_5	NH_3	SiH_4
	TiF_4	NH_3	SiH_4		TaI_5	NH_3	SiH_4
	TiBr_4	NH_3	SiH_4		TBTDET	NH_3	SiH_4
	TiI_4	NH_3	SiH_4		TaF_5	NH_3	Si_2H_6
	TEMAT	NH_3	SiH_4		TaCl_5	NH_3	Si_2H_6
	TDMAT	NH_3	SiH_4		TaBr_5	NH_3	Si_2H_6
	TDEAT	NH_3	SiH_4		TaI_5	NH_3	Si_2H_6
	TiCl_4	NH_3	Si_2H_6		TBTDET	NH_3	Si_2H_6
	TiF_4	NH_3	Si_2H_6		TaF_5	NH_3	SiH_2Cl_2

TiBr ₄	NH ₃	Si ₂ H ₆		TaCl ₅	NH ₃	SiH ₂ Cl ₂
TiI ₄	NH ₃	Si ₂ H ₆		TaBr ₅	NH ₃	SiH ₂ Cl ₂
TEMAT	NH ₃	Si ₂ H ₆		TaI ₅	NH ₃	SiH ₂ Cl ₂
TDMAT	NH ₃	Si ₂ H ₆		TBTDET	NH ₃	SiH ₂ Cl ₂
TDEAT	NH ₃	Si ₂ H ₆		TaF ₅	NH ₃	SiCl ₄
TiCl ₄	NH ₃	SiH ₂ Cl ₂		TaCl ₅	NH ₃	SiCl ₄
TiF ₄	NH ₃	SiH ₂ Cl ₂		TaBr ₅	NH ₃	SiCl ₄
TiBr ₄	NH ₃	SiH ₂ Cl ₂		TaI ₅	NH ₃	SiCl ₄
TiI ₄	NH ₃	SiH ₂ Cl ₂		TBTDET	NH ₃	SiCl ₄
TEMAT	NH ₃	SiH ₂ Cl ₂	Al ₂ O ₃	Al(CH ₃) ₃	H ₂ O	-
TDMAT	NH ₃	SiH ₂ Cl ₂		Al(CH ₃) ₃	H ₂ O ₂	-
TDEAT	NH ₃	SiH ₂ Cl ₂	ZrO ₂	Zr(O-t(C ₄ H ₉)) ₄	H ₂ O	-
TiCl ₄	NH ₃	SiCl ₄		Zr(O-t(C ₄ H ₉)) ₄	H ₂ O ₂	-
TiF ₄	NH ₃	SiCl ₄		ZrCl ₄	H ₂ O	-
TiBr ₄	NH ₃	SiCl ₄		ZrCl ₄	H ₂ O ₂	-
TiI ₄	NH ₃	SiCl ₄	Ta ₂ O ₅	Ta(OC ₂ H ₅) ₅	O ₂	-
TEMAT	NH ₃	SiCl ₄		Ta(OC ₂ H ₅) ₅	H ₂ O	-
TDMAT	NH ₃	SiCl ₄		Ta(OC ₂ H ₅) ₅	H ₂ O ₂	-
TDEAT	NH ₃	SiCl ₄				

[0132] TiCl₄ and NH₃ are supplied in the order of TiCl₄ and NH₃ in the first embodiment and the third to sixth embodiments described above, and TiCl₄, SiH₂Cl₂, and NH₃ are supplied in the order of TiCl₄, SiH₂Cl₂, and NH₃ in the second embodiment, but the supply order is not limited to these orders. The same applies to the treatment gases shown in the aforesaid Table 1.

[0133] The capturing unit 46 is disposed in the third embodiment, but the structure in which the capturing unit 46 is not disposed may also be adopted. The tape heater 80 may be wound around as in the fourth embodiment. Further, N₂ is supplied into the exhaust pipe 42, but other inert gas may be supplied. Moreover, though N₂ is supplied into the exhaust pipe 42 at the time of the supply of TiCl₄, it is also possible to start supplying N₂ into the exhaust pipe 42 before the supply of TiCl₄.

[0134] In the fourth embodiment, the exhaust pipe 42 is heated to 60°C to 100°C, but the heating temperature is not limited to a specific value as long as it is the temperature causing the

evaporation of the metal-containing gas. For example, when the metal-containing gas is TaF_5 or TaCl_5 , the exhaust pipe 42 is heated to 80°C to 200°C . When the metal-containing gas is $\text{Al}(\text{CH}_3)_3$, $\text{Zr}(\text{O}-t(\text{C}_4\text{H}_9))_4$, or $\text{Ta}(\text{OC}_2\text{H}_5)_5$, the exhaust pipe 42 is heated to 80°C to 150°C . Further, the exhaust pipe 42 is heated after the wafer W is carried in, but it is also possible to start heating the exhaust pipe 42 before the wafer W is carried in or while the wafer W is being carried in.

[0135] In the fourth embodiment, the capturing unit 46 is disposed, but the structure without the capturing unit 46 may also be adopted. The tape heater 80 is wound around the exhaust pipe 42, but any other type is usable as long as it can heat the exhaust pipe 42.

[0136] In the fifth and sixth embodiments, any of the capturing unit 46, the N_2 supply system 70, and the tape heater 80 is not disposed, but it is also possible to dispose at least one of these components. In these cases, a larger amount of TiCl_4 can be captured.

[0137] In the first to sixth embodiments, the wafer W is used, but a glass substrate may be used. Further, the explanation is given on the deposition device 1 that forms a film by alternately supplying TiCl_4 and NH_3 or by supplying TiCl_4 , SiH_2Cl_2 , and NH_3 by turns, but the present invention is also applicable to a deposition device that forms a film by supplying these gases simultaneously.

[0138] In the first to sixth embodiments, the chamber 2 is evacuated to exhaust TiCl_4 and so on, but it is also possible to supply a purge gas such as N_2 into the chamber 2 at the time of the evacuation. It is also possible to repeat the supply of the purge gas and vacuuming. Moreover, the present invention is applicable

to an etching apparatus, not limited to the deposition device. In this case, at least two kinds of etching gases may be alternately supplied or simultaneously supplied.